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ABSTRACT

This paper describes a total-program application of the systems engineering concept of the U.S. Coast Guard aviation training programs. The systems approach used treats all aspects of the training to produce the most cost-effective integration of academic, synthetic, and flight training for the production of graduate Coast Guard aviators. The paper describes the techniques used to develop job-relevant terminal behavioral objectives (the Coast Guard search and rescue flight mission provides the operational context); the assignment of objectives to academic, synthetic, and flight training; the integration of these components into a systems-engineered training program; the development of relatively objective proficiency assessment techniques; and the development of a flying training quality control system for maintaining and enhancing instructional efficiency and for management of the training system. (Author)

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Systems Engineering of Coast Guard Aviator Training

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16. Abstracts

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Prefatory Note

This paper describes research performed by the Human Resources Research Organization, Division No. 6 (Aviation), Fort Rucker, Alabama, under AVTRAIN, A Study of U.S. Coast Guard Aviator Training and Training Device Requirements, and sponsored by the Coast Guard (Department of Transportation). Dr. Caro served as Principal Investigator for the study; Mr. Hall is a member of the staff of HumRRO Division No. 6.

SYSTEMS ENGINEERING OF COAST GUARD AVIATOR TRAINING[1]

Eugene R. Hall and Paul W. Caro

In early 1969, the U.S. Coast Guard, seeking advantages that may be achieved for pilot training by acquiring modern synthetic flight training equipment, requested the Human Resources Research Organization to undertake a study to support their procurement efforts. Initially, the study was to define the characteristics of simulation equipment that would be useful in current aviator training programs. Later, the writing of simulator performance specifications and the development of training programs for pilots of the two Coast Guard helicopters were included. In short, the work was to include the development of a complete training system for these aircraft—a system based on operational requirements and training technology and not bound by past practices and traditions.

The systems engineering methodology has guided our approach to this study. Although this approach to training program development is not new, it has not achieved its full potential in practice because most applications tend to be unduly bound by constraints on training that are often imposed from outside. As a result, the typical application of systems engineering to training is less than optimal (1). The application to Coast Guard flight training described herein is one of the most comprehensive efforts undertaken for a military pilot training organization. Because of the foresight of the Coast Guard, there is an opportunity to systems engineer a complete training program. As we describe some of our activities, certain of the differences between this program and other training program development efforts may become apparent. Many similarities between our effort for the Coast Guard and the recently completed Air Force Undergraduate Pilot Training (UPT) studies can be recognized.

Over the years, HumRRO has developed a particular methodology for the systems engineering of training (2). We will describe briefly the application of the procedure to the Coast Guard's aviator training requirements.

DEVELOPMENT OF TRAINING OBJECTIVES

In accord with the systems orientation, the first major task was to define the objectives that training should achieve. The process began with an analysis of the search and rescue (SAR) mission and involved the determination of what a Coast Guard aviator needs to know and needs to be able to do to fly SAR missions operationally. Mission requirements were analyzed by inflight observation, through in-depth interviews with aviators, and by study of relevant flight and operating manuals. From these data, a list of tasks with associated knowledge requirements was prepared

[1]The material presented in this paper is based on research performed at HumRRO Division No. 6 (Aviation), Fort Rucker, Alabama, under U.S. Coast Guard contract. The opinions or assertions contained herein are private ones of the writers and are not to be construed as official or as reflecting the views of the Commandant or the Coast Guard at large. Reproduction in whole or in part is permitted for any purpose of the United States Government.

To determine the pretraining capabilities of Coast Guard aviators, a step necessary in order to exclude unnecessary training items from future courses, we identified the skills of present aviators and examined relevant portions of Navy Undergraduate Pilot Training (UPT). (Coast Guard aviators receive initial flight training from the Navy.) Existing capabilities were compared with the inventory of job tasks and knowledges. This comparison, by a subtraction process, yielded a broad set of behavioral objectives. Initially, these objectives consisted of statements reflecting only the capabilities that Coast Guard aviators require to perform operational roles. These general objectives, however, satisfied the requirement for information upon which to base specifications for the design of the simulators the Coast Guard planned to acquire.[1]

For training program development more refined statements of instructional objectives were required. The procedure used to develop these statements consisted of identifying all possible tasks (e.g., procedures, aircraft handling, planning, decision making, communications) that could be required during an operational mission. We specified each subtask involved and identified the action cues, timing, response sequencing, and possible contingency actions associated with each subtask. The knowledges required to recognize the achievement of the desired system states, the need for contingency actions, and the items of systems information necessary to the performance of tasks or subtasks, were also identified.

The tasks and subtasks were described in explicit behavioral terms. Standards, or criteria, for each, and conditions for observing performance were also specified. In most cases, subtasks related to aircraft operation contain an inherent standard of performance. For subtasks where no standards were obvious, they were developed. Generally, task standards consist of statements regarding the quality with which subordinate steps are performed, the necessity to perform all steps in the correct order with the proper timing between steps, and the ability to recognize and respond appropriately to non-normal indications.

Standards for procedural tasks were derived largely from information contained in the flight manuals. Some standards related to aircraft operation were derived from Coast Guard operating procedures that specify parameters (e.g., cruise airspeed, altitude) within which rotary wing aircraft are to be operated. However, for many visual flight rules (VFR) mission maneuvers, and for a number of instrument maneuvers, no standards were available from these sources.

For these maneuvers, it was necessary to determine the flight standards to which Coast Guard pilots could adhere. Data were gathered defining the performance tolerances that graduate aviators could maintain on representative flight parameters during various VFR and IFR maneuvers. These data were gathered in-flight using a data recording form based upon earlier HumRRO research (4). Time-lapse photography (5) supplemented the manual recordings of tolerances on the IFR maneuvers. The data collected were then used to define minimum acceptable performance criteria for attainment in future training programs.

LOCATION OF TRAINING

After performance objectives were established and standards were specified, it was necessary to decide where and how individual objectives or groups of objectives might

[1] For a more detailed discussion of the initial phases of the work described here, see Hall, Caro, Jolley, and Brown, 3. This document also describes transition, qualification and proficiency training, and the characteristics of aviators who will receive each type of training.

best be attained. This decision process requires consideration of all relevant factors that can be identified. Its validity is obviously dependent upon the expertise of the individuals making the judgments.

Most of the objectives were designated for training in a formal course of instruction at the Coast Guard's Training Center. Others were singled out for training at the aviator's follow-on unit of assignment. Practical considerations were largely responsible for allocating certain training to the follow-on assignment. For example, training associated with shipboard operations will not be conducted at the Training Center because of support problems that would be engendered if a sufficiently large vessel were to be maintained there for take-off and landing practice.

TRAINING PROGRAM CONSTRUCTION

Having allocated the objectives, our next activity was to construct a program of instruction in which trainees could acquire the skills and knowledges that were appropriate for Center training. This required consideration for training content, methods, materials, and media.

In determining the learning experiences that will lead to attainment of specific performance objectives, many critical questions must be addressed, for example, what is relevant content, what is the "best" way to schedule learning units, how should lessons be integrated?

We would like to note that in our view, systems engineering of training is primarily a behavioral technology that focuses on the needs of the student—it cannot succeed if only engineering concepts are followed. Currently, we are writing lesson plans and organizing training content for specific courses. Exercises for the practice of performance are being developed for both simulator and aircraft. Also, techniques are being selected for presenting systems information. It is planned that systems information will be taught within the context of specific operations requiring specific knowledge. The knowledge components of performance will be presented immediately preceding relevant practice in the simulator. Generally, our approach will be to teach a pilot what he needs to know to operate the aircraft systems from the cockpit, rather than teaching him how the systems operate.

In presenting successive lessons to the student, we plan generally to follow a phase-of-flight sequence. Items of skill and knowledge will be introduced in training in approximately the same order as events would occur within an operational mission. Also, to the extent practicable, training will be conducted within a mission context. For example, basic airwork (e.g., climbs, turns, descents) will be taught incidental to maneuvers rather than as separate items. Thus, the pilot will learn to change heading and altitude while practicing an instrument landing system (ILS) approach rather than practicing turns and descents in isolation. The efficacy of this approach has been demonstrated in recent HumRRO research (6).

Having decided what to teach, training equipment and instructional methods and media must be selected to create and present the appropriate learning experiences. The aircraft simulator will be the primary training tool. Training objectives not dependent upon external visual references will be met in the simulators. That is, all training that can be conducted in the simulator will be conducted there instead of in the aircraft. The aircraft will be used as a training vehicle for the conduct of training requiring the use of visual cues, that is, those items that cannot be trained to proficiency in the simulators since they have no extra-cockpit visual display. Programed instruction, video tape, and slide/tape materials for presenting operating and systems information are also being considered.

TRAINING ADMINISTRATION AND QUALITY CONTROL

The simulators are now under construction. When they have been installed, the training programs we are developing will be delivered, and Coast Guard instructors will be trained in their use. Appropriate revisions will be made in these programs based upon data obtained during their initial administration.

As part of our systems approach, we will develop a training quality control program modeled after similar programs HumRRO has developed for the Army (7). The quality control program will permit a continuing assessment of the efficacy of the training in terms of its responsiveness to operational performance requirements. Data from it will be used over time to identify latent or emergent deficiencies in training, as well as to facilitate the determination of trainee proficiency. The Coast Guard will have a management tooi for maintaining training program quality at a high level.

SUMMARY

The HumRRO Aviation Division is working on the systematic development of programs of instruction for Coast Guard aviator training, applying systems engineering concepts. Terminal performance objectives reflecting required job skills and knowledges have been prepared from study of the operational flying job and student pretraining capabilities. Lesson plans are being developed to define the learning experiences required for student attainment of training objectives. Techniques are being selected for presenting the training and for proficiency checking. In addition, a training quality control program is being developed for use in maintaining graduate quality while insuring the continued responsiveness of the training program to operational performance requirements.

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